forming species, the fittest species diverging into genera, and from genera to families and so on to orders.

We thus have arising from the primordial protoplasm two mighty trunks, the vegetable and animal, with branches and secondary branches, and smaller divisions, —like giant trees, extending down through the ages. Many branches have died out, leaving the living more vigorous. The places of the living species on these genealogical trees are at the ends of the living branches. There has been no break in the line of descent from the earliest to the present forms. The highest now living have lineally descended through innumerable generations from the simple organisms that were the only inhabitants of the Earth in earlier geological periods. In species as in individuals the fittest have survived, and those least fitted have perished. Only a few of the many early species are represented by living forms. Species weak in numbers, and with many competitors equally or better adapted to the prevailing conditions, had to die out. Hence we see that from the first there has been, as the geological record proves, a succession of constantly improving organisms; and we comprehend why it has been so.

If all the dry land should become partly submerged to the extent of converting it into marshes, it is evident that the direction of development would be changed, and the higher animals and plants would under natural selection, deteriorate to conform to the new conditions. There have been plenty of places from the start, unfitted for the higher organisms, and therefore voluntarily abandoned to lower forms. The infusorian is at home in a drop of stagnant water, and any considerable evolution of its structure would be detrimental, so it remains for millions of years an infusorian—if its environment remain un-

changed. This holds true to a certain extent with all organisms. It follows that we have living at the same time the higher organisms peculiar to recent times, and many of the lower types holding over from earlier periods. As long as there are places only fitted for the lower orders of animals and plants, they will be occupied by such, and little or no advance will be made among them. The competition from among higher forms remains at a minimum.

Again Darwin: "As buds (of a tree) give rise by growth to fresh buds, and those, if vigorous, branch out and overtop on all sides many a feebler branch, so by generation I believe it has been with the great Tree of Life, which fills with its dead and broken branches, the crust of the Earth, and covers the surface with its ever branching and beautiful ramifications."

Under the conditions arising from ceaseless and untiring change in everything pertaining to our planet, it happens that no two individuals are begotten under the same general conditions, nor, even if of the same parentage, from the same admixture of exactly the same sexual elements. When this fact is fully considered, it becomes at once evident that variation in the character of the offspring, must be the general rule. Still more light is shed upon the causes of variation and also of heredity, when we consider that the newly conceived organism is composed of particles of the actual substance of its parents; and that this substance has the attribute of increasing in size by the assimilation of nourishment, without losing its original peculiarities.

Organisms are modified to some extent by climate, food, associations, etc., during the plastic period of their lives.

Effort put forth by a highly developed animal leads to

action that strengthens the organs that are used the most. Conscious effort may therefore be one of the causes of development, but not a primary cause, for the effort itself is an effect, and may generally be traced back to an initiative cause or causes.

It is a matter of common knowledge that use strengthens, and disuse weakens, organs. The microscopist's eye that is used the most, if the work required of it is not excessive, becomes stronger than the other. The increase in size and strength of the right arm of a blacksmith is a case in point. This principle is familiar to those who use the bicycle, do manual labor, or train to develop muscle. There can be no doubt that the modifications brought about through effort, use and disuse, are transmitted to offspring. Disuse has weakened and diminished the wings of such birds as the ostrich and the Brahma fowls, and other large-bodied, small-winged, non-flying fowls, while their legs being used more have increased in size. Moles, habitually burrowing in the ground have little use for their eyes, consequently they have become almost blind and in some cases the eyes have become skinned over. To compensate, their noses are highly developed and sensitive to the touch, being in constant use to feel their way. The star-nosed species with developed nose-feelers is especially remarkable. Fishes living in dark caverns, having no use for eyes become blind, like those in the Mammoth Cave, Kentucky. They are not only blind but the eyes are under the skin. The presence of partly obliterated eyes proves that the fish were not designedly created blind, but that they have become so by modification through disuse. Besides, they are connected by gradations of structure with species having normal eyes.

Organs are sometimes developed through natural se-

lection partly at the expense of less useful adjacent ones. The increased use of the brain by the more highly civilized peoples, and the decreased use of teeth because of the food being more finely prepared, and requiring less mastication, has tended to produce better brain and poorer teeth. The part that is most used will receive the greater flow of blood, and therefore the most nourishment.

The flank-membrane of the squirrel is, in some species, more or less distended, and in the flying squirrel it is so greatly distended, as to unite their limbs and the base of their tails, so as to form an imperfect substitute for wings. They can sail to a considerable distance and so escape their enemies, secure food in otherwise inaccessible places, and avoid injury in case of accidental falls. The extreme of this remarkable kind of variation is reached in the hands and fingers of bats, and becomes more useful by reason of the character of their food.

In studying the probable origin of complex and highly differentiated organs, like the eye, we must trace them backward to simpler forms. We have in the infusoria eyes that are merely more delicate and sensitive spots. Bare nerves are sensitive to air-waves, heat, and if very delicate, doubtless to light. The simplest forms of eyes in the lowest living animals are not much if any more than ends of nerves shaded with pigment cells. The gradation from these to the eyes of the mammalia is tolerably complete, and with a perfect geological record would be quite so ; but, of course a structure as delicate as the eye could not be expected to be well preserved in a fossil state. However, in no other way are such delicate organs so well accounted for as they are by the theory of natural selection ; and it is done to the satisfaction of the naturalists best qualified to judge.

The dust that covers the wings and bodies of butter-

flies, moths, mosquitos, and some other insects, is seen under the microscope to be scales arranged in rows overlapping like shingles on a house. The scales are modifications of protuberances of the skin, and vary in shape, all the way from true cylindrical hairs to flat scales as wide as they are long. The scales of fishes are similar modifications of the skin. The hair of the higher animals is but a modification of the same kind. It answers for clothing, defense, and ornament. It is correlated with the nails and teeth. By natural selection all intermediate grades of hair are produced, from fine fur and wool to the defensive barbed quills of the hedgehog and the porcupine. In the birds may be seen true hairs, hairs with branches, and variations all the way to highly developed ornamental feathers. Many of these modifications have been brought about by selection under domestication.

When a person allows his thoughts to run in any certain direction a second time, he finds the movement easier than the first, and so on by repetition until a habit of thought is established, and the person thinks in a groove, as we might say. The first disturbance of the molecules of the brain cells form a memory record, and the subsequent impressions strengthen it until it assumes undue relative importance and the person becomes biassed or "cranky" in that direction. Such impressions may become stronger than those produced through the eye or ear by external objects; and when they do so, they may have as great or greater force with the individual than objective impressions, and thus cause the person to be subject to hallucinations. Or, falling short of hallucination, habits of thought may be established, and perpetuated by the laws of inheritance, the same as habits of action are transmitted. Habit is

then an important factor in natural selection. It is easy to fall into habits of thought or action, and still easier in the direction of inherited tendency. In this way habits are formed that possess all the force of instinct, and cannot be distinguished therefrom.

It will be remembered that bees, ants and other of the higher insects existed quite early in geological times, so they have had an enormous period in which to perfect beneficial habits, acquired little by little through natural selection. Tiny chunks of wisdom, scattered through the ages, have been aggregated into the perfection of the hexagonal cell of the honey bee, and its system of labor, so that little direct reasoning is now necessary in their communities. This is instinct which was once reason. Yet, experiments have shown that honey bees will vary their methods somewhat to meet new conditions; they have some reason as well as inherited skill. There are allied species of bees that construct more simple cells, and not always the perfect hexagon. We have here as everywhere, the gradation of structure showing the handiwork of natural selection; the opposite of special creation. The humble-bees make, as every country boy knows, irregular, rounded cells, and there are other species of bees that make cells intermediate in form between those of the humble-bees and the hive-bees.

We, ourselves, have instincts that we sometimes follow when reason would have been the better guide.

Some aphides secrete a sweet juice of which ants are very fond. Some species of ants keep and take care of these aphides for the purpose of having the juice, as men keep cows for their milk. They care for the eggs of the aphides, pasture the insects on neighboring plants, attend to their safety in times of danger, and in

return the aphides voluntarily yield the sweet juice when the ants require it. Their aphides are in every respect domestic animals. Some species of ants are so very highly "civilized" as to make long marches (for them), form in regular order, and fight fierce battles, and kill or make slaves of prisoners. Some use prisoners for domestic servants, not permitting them to go outside the hill. In time the ants held as servants become contented and faithful. The properties of protoplasm are made manifest in much the same way through ants as though men. Nature has given like results, or different results, according to the varying conditions through which each has passed from a common ancestry in the early days of our planet. The ants possibly look up to us big fellows as divine beings, creators of the great fields they have traversed, and the little Sun and Moon. Let us be just and kind to them, and if any among them shall be honestly mistaken, not cut off every chance for reform by visiting upon them a punishment that endureth forever. Let them be judged by their works and not by their beliefs. We must not expect them to be better than the beings they worship.

We see the same causes operating now that brought about the changes during the geological periods. Then as now, as a general rule, as species succeeded each other in time, they were higher in the scale of evolution. There is no gap between the past and the present ; they insensibly connect. The theory of descent with modifications explains in a natural way, and in accordance with generally recognized principles, the facts as known. Every new discovery made in the incomplete geological record, strengthens the Darwinian hypothesis, by adding another intermediate form to those already known. The origin of species by natural selection through descent, is

now believed in by workers in all branches of science. From the start of the first living form up to the present time, it is conceded by those competent to judge, that there has been no act of special creation among organic beings.

If anything more could be needed to strengthen this view, this question of Darwin's would be sufficient: "What can be more curious than that the hand of man, formed for grasping, that of a mole for digging, the leg of the horse, the paddle of the porpoise, and the wing of the bat, should include the same bones, in the same relative positions?"

The great similarity of all organic beings is noticeable throughout,—in chemical composition, and in susceptibility to changes in temperature and food. They are all, vegetable as well as animal, delicately balanced, and easily influenced by the slightest changes. The connection is close, and incompatible with the idea of special creation by a being possessing much versatility.

From the point of view of the believer in the duality of the Universe, and intelligent creative action in any form, the phenomena of life, the gain of the few at the expense of the many, the inexorable operations of nature, if performed by an all-powerful being would be unjust, and unworthy. How true and apt are the words of Darwin "When I view all beings not as special creations, but as the lineal descendants of some few beings, which lived long before the first bed of the Silurian system was deposited, they seem to me to become ennobled." As to our duty, he said, "Whoever is led to believe that species are mutable, will do good service by conscientiously expressing his conviction; for only thus can the load of prejudice by which this subject is overwhelmed be removed."

To some minds the strongest evidence in favor of natural selection, and against the special creation theory, is found in organs that have become rudimentary. Rudimentary organs that are not only useless, but actually detrimental, exist, and according to the idea of special creation of fixed species, must have been so created; an utter absurdity; whereas they are readily explained by natural selection,—as parts undergoing elimination through disuse; but having been at one period useful to the ancestors of the present species. Organs, like species, when of no further use, become degenerate, and finally extinct. The loss of old organs, or species, is the necessary consequence of the development of new ones. When new and vigorous shoots come on a tree,—old limbs are robbed of their nourishment, and die out. This is one of the necessary processes of evolution.

Almost every kind of plants or animals has rudimentary organs. Rudimentary eyes under the skin of animals who have no use for eyes, and the wings of birds that do not fly, were previously mentioned. Very many insects have rudimentary wings. This is especially the case with two-winged species of insects; they having descended from four-winged ones, and have lost or partly lost the hinder pair of wings. The halteres of the common flies, just back of the wings, are rudimentary wings. In the different species of the Diptera, a gradation in this modification may be traced. Only microscopic traces of the ancestral wings remain.

Darwin speaks of the presence of teeth, never to be used, in the jaws of fœtal whales, in the upper jaws of unborn calves, and in "the beaks of certain embryonic birds." These now disappear in the mature animal. Most of the higher animals have muscles that are not used. To this rule man is no exception. The muscles

that moved the ears of our ancestral apes in a lively manner, in us are present, but so feeble that few men can move their ears at all;—some by great effort, can do so. As a rule, with only a few exceptions, the mammary glands of all male animals are rudimentary. The crescent shaped fold of skin in the corner of the eye is all that remains of a membrane that, in some animals can be stretched across the whole eyeball to protect it. Fishes now living, allied to those of the Silurian period from which we probably lineally descended, possess this membrane fully developed.

The great German naturalist, Haeckel, said in his *History of Creation*, speaking of superfluous rudimentary organs: "Another of them is the rudiment of the tail, which man possesses in his 3 to 5 tail vertebræ, and, which, in the human embryo, stands out prominently during the first two months of its development. It afterwards becomes completely hidden. The rudimentary little tail of man is an irrefutable proof of the fact that he is descended from tailed ancestors. In woman the tail is generally by one vertebra longer than in man. There still exist rudimentary muscles in the human tail which formerly moved it."

The vermiform-appendix, hanging from the cæcum, is a modification of the intestine in man and some of the higher apes and the wombat. It may still be of some use in secreting mucus to act as a lubricant to the ileo-cæcal valve, and for this reason has not been entirely obliterated by natural selection; but in many cases it is a positive damage to the individual, causing the dangerous disease called appendicitis.

In birds, only the left ovary is developed and yields eggs; the right is aborted. Where by reason of modifications of structure, useful in important respects, there

does not remain sufficient room for the usual pair of organs, one does the work and the other becomes rudimentary. This is also the case with the lungs of serpents ; their bodies being long and narrow there is not room for a pair of well-developed lungs.

The life history of each individual frog exhibits before our eyes a most wonderful metamorphosis performed in a short time. The parent generative cells develop into the ovum, and from the ovum comes the tadpole. It has a tail used for swimming, no legs, no lungs, breathes by gills like a fish, and is aquatic and herbivorous. Two pairs of legs begin to bud, the gills are gradually absorbed as the lung air-cells form, the tail atrophies, and is finally completely absorbed, and the young frog leaves the water—with four good legs, a lung-breathing animal. This is all accomplished in a few weeks in billions of individual instances in a perfectly natural way, without the miraculous creative interference of divine providence.

These changes that we observe in one individual required for the race whole geological periods to accomplish. The present frogs have developed from lower forms by the processes of natural selection,—passing through the stages the individual illustrates. The growth of the individual is typical of the development of the race.

One great object in writing this book will be accomplished, if it helps to lead the readers to consult the best standard works for more complete information on matters here necessarily only briefly considered. Another, and still greater object would be attained if the reader should go directly to the fountain head, Nature, to investigate and learn the truth for himself; first banishing from the mind all that is possible of the per-

versity of the bias common to us all through inheritance.

Haeckel, in his careful and thorough study of the calcarious sponges, found not only that all the species had a common origin in one ancestral form; but he found several forms that "have been regarded, not only as belonging to different species, but even to different genera, all growing out from a single 'stock' or 'cormus.'"

Another strong proof of the truth of the theory of descent is found in the distribution of animals and plants. They are found at present not as if distributed from any arbitrary center or place of creation, but on the contrary are found as they would be if descended from allied geological fauna and flora. Thus the past and the present are connected, the present distribution agreeing with the changes resulting from continental changes.

It might very reasonably be inferred that primitive life originated in the regions where the Earth's crust first cooled,—near the poles. That there was at a much later period a continent, now submerged, in the Pacific ocean, that had much to do with the development and distribution of plants and animals, including varieties of men, has been rendered probable by the researches of Alfred R. Wallace in the Malay Archipelago. An important part of the geological record, especially concerning the human race, may lie buried beneath the waters of that ocean.

In tracing backward the origin of civilization, from the west toward the East, from Europe to Egypt, from Egypt to Central Asia, and on to China, the extreme eastern limit may not have been reached. Some of the gaps in the geological records may have had the

same cause. However this may be, as a rule the types of the inhabitants during geological times continue in their different areas unless disturbed by great changes like those causing the Glacial period. Subject to whatever changes may be due to migration, the present species occupy the same areas where their ancestors lived and developed.

Migration to the extent of considerably modifying the character of the inhabitants of some districts has taken place, caused by changes in the level of the land, change of climate, and the necessity of seeking wider ranges for food. Unusually heavy winds and floods assisted in carrying winged and other seeds, birds, insects, and accidentally, larger animals to new localities. Birds are also active agents in carrying seeds. Ocean currents, icebergs, streams, and various other causes have assisted distribution.

The various tribes of animals are intimately connected by gradual transitions in structure and functions. There are gradations in size all the way from animalculæ 1–50,000th of an inch in diameter, to whales weighing scores of tons. All the characteristic features of tissue and structure are connected by intervening gradations with the principal types. Physically, man is connected with the amoeba by thousands of intermediate forms. The mental development is parallel with the physical. The brain of man is no exception to the general rule of evolution. There are all grades of development in the nervous system from undifferentiated sensitive protoplasm or sarcode, to nerves, ganglia, cephalic ganglia, and the brain proper.

The vertebrate animals begin with the Amphioxus, which has no brain; in lampreys there is a modification or division of the end of the spinal marrow, which,

in the fishes may first be recognized with certainty as a tiny brain with cerebellum and cerebrum. In the reptiles the structure is still further advanced, and in birds the cerebrum is more decidedly larger in proportion, and the entire brain more complex. In mammals there is still further increase in complexity, and in the relative size of cerebrum to cerebellum, and of the whole brain to the bulk of the animal; this organ reaching its climax in man. The skeleton and the circulatory and respiratory systems show similar gradations upward through all these classes of animal life.

In the vegetable kingdom connected gradations from the simple to the complex are everywhere to be observed. The bacterium and the oak are connected by an evolutionary chain. All organic beings are united in a continuous network. The continuity from the lowest to the highest is complete and unbroken. We are all necessary parts of the same great, natural system. Through natural selection the effete branches and ramifications have died out, and those best fitted for the unstable conditions of life survive through their lineal descendants. Success in the struggle for existence was, and is, the reward of adaptation. Without plasticity all would have become extinct, or been confined without improvement to areas where the conditions of life remain stable.

Fidelity to the truth requires that we must not ignore the fact, that with man as with the lower animals, mental as well as physical characteristics are transmissible to offspring; and therefore must necessarily have been inherited. Diseases of the lungs, liver, or of the mind; peculiarities, such as pride, ambition, fixed ideas and beliefs are subject to the laws of inheritance. It follows that mind and body are subject to the same

laws of natural development. The student cannot, in his inner consciousness, deny the truth of Haeckel's conclusion: "This distinctly and irrefragably shows that the soul of man, just as the soul of animals, is a purely mechanical activity, the sum of the molecular phenomena of motion in particles of the brain, and that it is transmitted by inheritance, together with its substratum, just as every other quality of the body is naturally transmitted by propagation."

Every physician understands that the processes of digestion and generation, and the susceptibility to remedial agents are substantially alike in the higher animals and man. There is little to distinguish man from the higher species of the lower animals in the number and location of the bones or muscles. The principal differences will be found in shape and size.

When we come to compare their minute structure, with the microscope, nearly all distinctive features are lost. In many species the blood corpuscles are distinguishable from those of man only by their size; and there are a few species where the difference is too small for measurement with the highest powers, and the finest and most accurate micrometers. The microscopic structure of the bones is equally close, as shown by very thin transverse and longitudinal sections. This is also true of the fibers of the muscles, and the still more minute fibrillæ of which each individual fiber is composed. Nerves and brain show the same similarity in their ultimate analysis. Using first-class instruments with the best illumination, I am unable to distinguish between the finer tissues of the several higher species of animals, including man. The structure of the eyes, the capillaries of the liver and lungs, the Malpighian tufts and uriniferous tubes of the kidneys, the glands of the alimentary

canal, the mucous membranes, the cells throughout, all proclaim the kinship of man and the higher animals.

To establish the truth of a theory it is not required that every little objection must be answered, especially when all the facts have not been discovered; but it must afford the best explanation of the known facts. This the theory of descent certainly and easily does. Enough, and more than enough has already been advanced in this chapter, supplementing as this theory does the nebular hypothesis; but the crowning argument I have reserved for the last paragraphs.

Prof. Haeckel, in his *History of Creation*, compares with each other the embryos of a tortoise (at 4 weeks), a chick (at 4 days), a dog (at 4 weeks) and a man (at 4 weeks). In the earlier stages of development it was impossible to distinguish between the four. In the stages above indicated, the form and little stubs of limbs, no fingers or toes at this stage, were the same, and the brain very nearly. Everybody knows the gills of a fish and the gill-arches to which they are attached. Now, each of the embryos of course including that of man, showed unmistakably the three gill-arches. They are in the embryos of all vertebrates. They only remain in the mature animal in fishes. This is positive proof that man and the other vertebrates descended from and through some fish-like animal.

A tortoise (at 6 weeks), a chick (at 8 days), a dog (at 6 weeks), and a man (at 8 weeks) are also compared. The gill-arches have disappeared. The brains of the mammals differ from the other two, yet the brain of the dog is almost like that of the man. Excepting the chick they all have five toes, and all just alike including the fingers of man. The "missing link" that would-be facetious writers have had so much to say about was

also discovered. In all these eight specimens the tails were of about the same length and shape. So each and every individual human being, whether he be peasant or emperor, has passed through the stages of gill-breathers,—and tail-bearers.

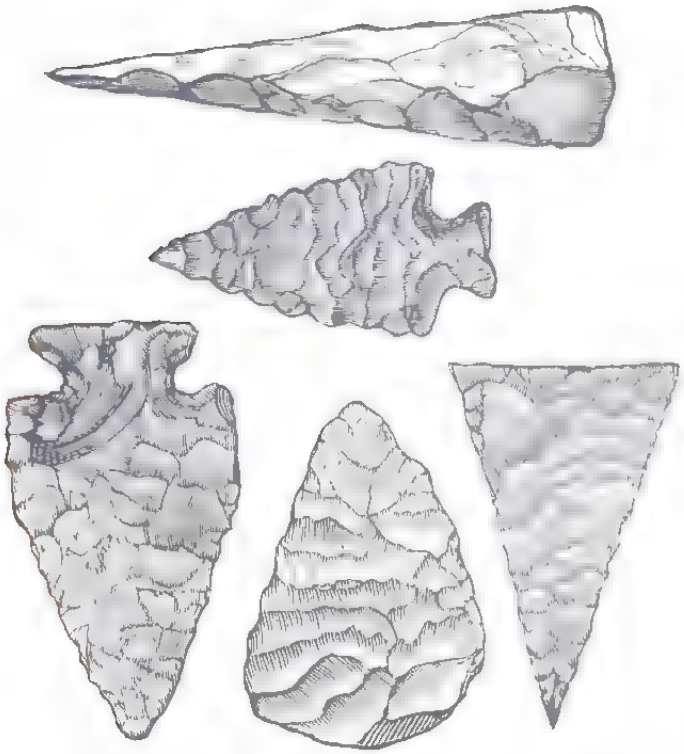
In this—the growth of the individual through these changes in so short a time, is more wonderful than the slow and gradual development of the race through the same structural changes. The life of each man is the type of the life of the human race.

CHAPTER XII.

FROM ROCKS TO BOOKS.

PRE-HISTORIC TIMES, is the title usually given to the indefinite period of time connecting the testimony of the rocks with the testimony of written history, and covered by the science of Archæology. Archæologists attempt to supply the evidence lacking in the later geological periods, and in the time preceding authentic history. That this period was of great duration there is no longer room to doubt. It is divided into four great epochs: The Palæolithic period, where geology left animals now extinct living at the same time with primitive man, and the stone implements he made were not polished; the Neolithic period, or Polished Stone Age, where metals were not yet worked; the Bronze Age, in which cutting implements were made of bronze; and lastly, the Iron Age, when iron took the place of bronze except for ornament, and men began to leave written records.

The early, crude flint implements are found widely scattered in both hemispheres, and under conditions that prove the presence of man during the subsidence of the continental ice sheets of the Glacial period. When we consider the great numbers of flint implements that have been found, and how common are



IMPLEMENTS OF CHIPPED STONE. EUROPE.

IMPLEMENTS OF POLISHED STONE. EUROPE.

specimens of them among the people; and how small they are compared with the extensive territory over which they were lost in the chase or in conflict, so that probably where a million have been scattered, only a few have been found; it follows that the time included in the stone age must have been of great length, even assuming the population to have been dense. Judging by what is known of the aboriginal races there could not have been, generally speaking, a very dense population in the remote past.

Some little use had been made of copper from the Lake Superior region; but, in the main, the American Indians were in their stone age when Europeans began to colonize the Atlantic coast. Therefore the slow distribution of flints had been going on from the Glacial period, and probably from the Pliocene, and has continued until a very recent date.

With man as with the lower animals, some hardy, primitive types hold over and live contemporaneously with their more advanced brethren; protected from extermination by distance, deserts or seas.

During the earlier period, the Palæolithic, the workmanship was extremely crude. Many thousands of years were required in which to make a little advance. This, however, has been the experience of the world all along, until the new methods of Science obtained a foothold, and men began to look to the living present for inspiration.

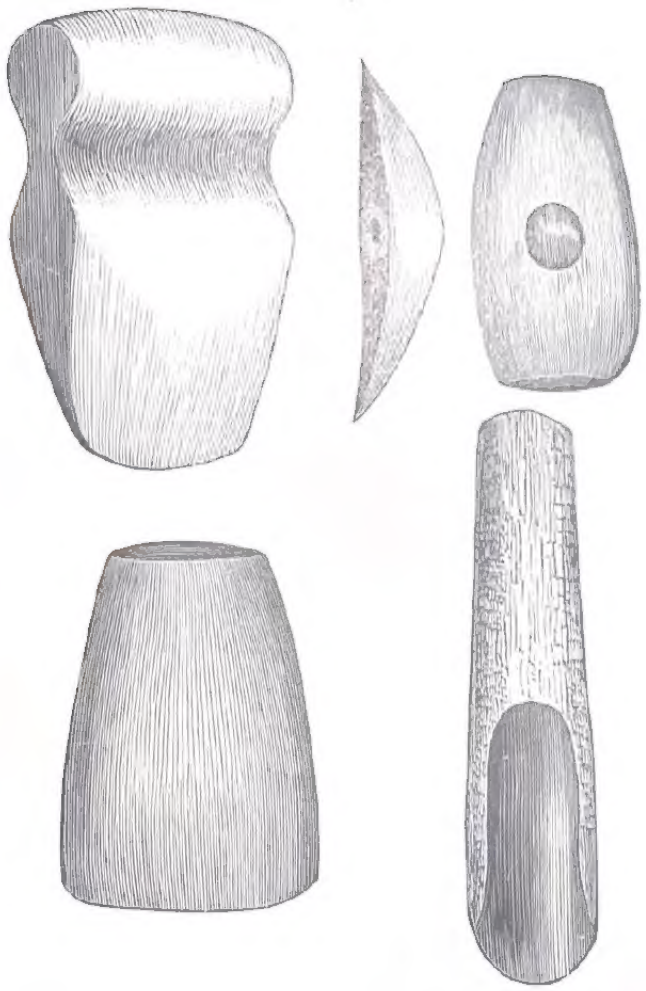
Some of the higher apes use clubs, and monkeys have been known to open boxes with sticks; but it is a great step from this level to the construction and use of even the crudest artificial tools. This advance was probably attained by degrees, and after the ancestors of the human race had habitually assumed the upright

attitude, even when not in the immediate presence of danger. We can imagine that wooden weapons and implements preceded those of stone. Trees felled by wind or lightning furnished broken limbs that required little shaping to become formidable war-clubs. Broken stones were useful to cut, and scrape, and smooth the jagged parts. Flint flakes being more useful were selected. It was a long ways but an even journey from the crude flint to the symmetrical arrow-head and the polished implement. It was the road along which the struggle for existence had led, and has since led, to the survival of the fittest. The laws of natural selection that led to the evolution of the constructive animal also governed in the evolution of the products of his hands and brain.

When the Palæolithic age began, only the favored few could own flint-flakes; wooden sticks were good enough for the many. The proud and arrogant possessor of a flint-flake was the lord of his day and generation, the forerunner of the modern aristocrat. How the last man of that age must have felt when he saw the dawn of the Neolithic age, and the coming man with the polished implements, teeth beads, and borrowed feathers. Nothing could be done; he had had his innings. Let his successors profit by his example.

His flint weapons, and occasionally some of his bones, are found by his descendants, mingled with the bones of the mastodon, the mammoth, the cave-bear, and a number of other animals which became extinct so long ago that no traditions of them were left to be recorded by the earliest historians.

The number of flint implements in public and private collections runs up to hundreds of thousands. During the stone ages, harpoons, needles, pins, etc., were made of bone, and often showed considerable skill. There



IMPLEMENTS OF POLISHED STONE. NORTH AMERICA.

are evidences of the division of labor, places being found where implements were extensively manufactured. Stone mortars, pestles, hammers, chisels, scrapers, gouges, axes, hatchets, arrow-heads, lance-heads, sinkers, etc., show all grades of workmanship.

These comparatively imperishable works enable us to form quite accurate opinions of the conditions of life in the infancy of the human race. They seem to have been very much the same as they are to-day among the more savage tribes. Trace backward the most highly civilized nations and we find a savage ancestry. We all laboriously ascended the same ladder and never missed a rung. To understand the past we have only to study its relics in connection with the daily lives of existing tribes.

As some evidence of the care with which scientists have conducted their researches reference may be made in this connection to the works of Sir Charles Lyell, Sir John Lubbock, Prof. Huxley, and the proceedings of the British and the American Associations for the Advancement of Science. The British Association has at different times appointed committees to make excavations, and thoroughly investigate certain caverns. Considerable money was appropriated, and the work was done with great care. A cave at Brixham showed flint-flakes mixed with the bones of numerous extinct species of animals, and appearing to be of the same antiquity. They were found at various depths; some of them in the gravel, eleven feet beneath the surface and covered with layers of cave-earth, with comminuted shale, and limestone breccia and a layer of stalagmite. The story of the cavern of Kent's Hole, and caves in Belgium, Sicily, France, etc., is the same. In one cave in England, Roman remains that are

known to antedate our era were found only slightly coated with stalagmite, while flint implements were found beneath an undisturbed deep layer of the same substance. There were strong indications that the deposition of stalagmite had been continuous and at about the same rate. Perhaps the most remarkable cave-finds are the sketches on bone or stone, of fish, reindeer, ibex, horse, mammoth and man.

The oldest human skulls and bones found in caves show that more than one race of men lived at an early period in Europe. Some of the skulls show, according to Prof. Huxley, "ape-like characters." It will not be considered far out of the way to assign to the cave-men a position about half-way both in time and development between the first men and the average of the present inhabitants. The more the subject is studied the more convincing becomes the evidence of the great antiquity of man. Crude flint implements found in the highest, and therefore oldest terraces in river valleys, prove that men hunted and fished along the rivers before the valleys were excavated by the water, but even then men were considerably advanced and widely distributed. Any so-called sacred, mythical, traditionary, or poetical chronology is pitifully inadequate.

The first metal that was very much used to take the place of stone in the making of implements was copper. At first it was wrought by beating into the desired shapes. It does not appear that the American Indians had acquired the art of casting it. It is said to have been used in China 2,000 years, B. C., and in India at probably a later period.

Primitive man has left behind him many evidences of his use of fire. In using this agent he had very early gained a great advantage over all other animals. Many